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FORTUITOUS DISCOVERY.

THE accepted principle of necessity being the mother of invention is, like many another maxim, misleading, and would be more accurately rendered by substituting for invention the word contrivance or device. The true meaning of the Latin *invenire* is to come or stumble upon by chance, and in this sense accident alone can claim legal parentage over any fortuitous discovery. Many things of the greatest service to the world in general owe their origin entirely to chance. The rubbing of a piece of amber 'evoked,' to use Faraday's words, 'an invisible agent which has done for mankind far more wonderful things than the genie of Aladdin did or could have done for him;' the up-forcing of the lid of a cooking vessel discovered the marvellous power of steam, and the falling of an apple from its parent stem demonstrated the law of natural attraction. The simple swinging to and fro of a suspended lamp gave birth to the application of the pendulum, to which the precision of modern astronomy owes so much; while the finding of the natural magnet loadstone 'did more,' said the grave philosopher John Locke, 'for the supplying and increase of social commodities than those who built workhouses.'

The manufacture of gunpowder, according to Sainte Foix, was thus revealed. An Augustinian monk, Berthold Schwartz, having put a composition of sulphur and saltpetre in a mortar, it took fire, and the stone that covered it was blown off with great violence, which accident led the chemist to think it might be used to much advantage in attacking fortified places. He accordingly added to it a quantity of charcoal to render it more apt to take fire and increase combustion.

Leaden shot are attributed to a Bristol plumber, who, one night about the year 1783, 'had a dream which was not all a dream' that he was out in a shower of molten lead, which fell in the form of spherical drops. His curiosity being aroused, he went next day to the top of a church and poured some melted lead into a vessel of water lying below. To his great delight, he found that the lead had gathered into beautifully-formed globular balls, and he at once took out a patent.

The inference that glass was discovered by accident is strengthened by the fact that it is scarcely possible to excite a fire to sufficient heat for metallurgical operations without vitrifying parts of the bricks or stones of the furnace.

A Nuremberg glasscutter happened to let some aquafortis fall upon his spectacles, and noticed that the glass was corroded and softened where the acid had touched it. Taking the hint, he made a liquid, then drew some figures upon a piece of glass, covered them with varnish, applied his corroding fluid, and cut away the glass round his drawing. When he removed the varnish the figures appeared raised upon a dark ground; and etching upon glass was added to the ornamental arts.

According to common report, mezzotinto engraving was suggested by a soldier being observed one morning to rub off the barrel of his musket the rust it had contracted from exposure to the previous night's dew. The observer—whether Prince Rupert or not is one of the doubts of history—perceived on examination that the dew had left on the surface of the steel a number of very minute holes, giving the appearance of a dark engraving, part of which had been here and there already rubbed away by the soldier. He therefore conceived the idea that it would be practicable to find a way of covering a plate of copper with little holes, which, being inked and laid upon paper, would undoubtedly produce a black impression; while, by scraping away in different degrees such parts of the surface as might be required, the paper would be left white where there were no holes. Pursuing this thought, after various experiments, he invented a kind of steel roller covered with teeth, which, being pressed against the copper plate, indented it in the desired manner. The roughness thus occasioned had only to be scraped down where necessary in order to produce any gradation of shade.

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One day nearly three hundred years ago, a poor optician was working in his shop in the town of Middelburg, in the Netherlands, his children helping him or amusing themselves with the tools and objects lying about, when suddenly his little girl exclaimed: 'Oh papa, see how near the steeple comes!'

Anxious to learn the cause of the child's amazement, he turned towards her, and saw that she was looking through two lenses, one held close to her eye, the other at arm's-length; and calling her to his side, he noticed that the eye lens was plano-concave, while the other was plano-convex. Taking the two glasses, he repeated his daughter's experiment, and soon discovered that she had chanced to hold the lenses apart at the proper focus, thus producing the wonderful effect that she observed. His quick wit saw in this a wonderful discovery, and he at once set about making use of his new knowledge of lenses. Ere long he had fashioned a tube of pasteboard, in which he set the glasses at their proper focus, and so the telescope was invented.

The following year, 1609, Galileo, while in Venice, heard of the discovery; and, being greatly struck with the importance of such an instrument, soon discovered the principle of lenses in a shifting tube, and made a telescope for his own use. To having been the first astronomer in whose hands so valuable a gift was placed, Galileo owed both his reputation and persecution.

Among the many traditions concerning William Lee and the stocking-frame is one that he was expelled from the university for marrying, and that, being very poor, his wife was obliged to contribute towards the housekeeping by knitting. It was while watching the motion of her fingers that he conceived how to imitate those movements by a machine.

Arkwright accidentally derived the idea of spinning by rollers from seeing a red-hot bar elongated by being passed between two rollers.

The ordinary practice of taking a bath solved for Archimedes the question of how to test the purity of the gold in Hiero's crown. He observed that when he stepped into a full bath the quantity of water which overflowed was equal to the bulk of his body, and it occurred to him that the worth of the crown might be tested by such means. He thereupon made two masses of the same weight as the crown, one of gold, the other of silver, and immersed them separately in a vessel filled to the brim, measuring exactly the quantity of water that overflowed in each case. Having found by this means what measure of the fluid answered to the quantity of each metal, less in the case of the gold than of the silver—the bulk of the former being less, weight for weight—he next immersed the crown itself, and found that it caused more water to overflow than the gold, but less than the silver. Having found the difference between the two masses of pure gold and silver, in certain known proportions, he was able to compute the real quantity of each metal in the crown, and thus discovered the fraud that had been practised on the king, to whom he hurried, exclaiming, 'Eureka! Eureka!' ('I have found it! I have found it!'), an exclamation that has ever since been used to express exultation over a discovery.

Coming down now to our own time, the account of the discovery of saccharine, one of the numerous by-products of the gas-maker's refuse, whose sweetness is three hundred times more intense than that of cane-sugar, reads almost like a romance.

Dr Fahlberg had entered the Johns Hopkins University in America in order to devote himself exclusively to a study of the chemistry of coal-tar derivatives. Some months had passed, when one evening at tea-time he detected an intensely sweet flavour upon his bread and butter. He traced the sweetness to his fingers, to his hands, and to his coat-sleeves; and it dawned upon him that it must have been derived from one of the new compounds which he had that day succeeded in producing. He promptly returned to his laboratory and tasted the contents of every vessel with which he had been working. His idea was correct. One of his beakers contained the sweet material.

Those who are conversant with the fascinating philosophy of Bishop Berkeley may remember the following passage in his *Siris*, which, read by the light of present knowledge and the imposing list of valuable substances—oils, dyes, perfumes, flavourings, febrifuges, &c.—now obtained in the process of coal-tar distillation, is almost prophetic: 'The virtues of tar-water flowing, like the Nile, from a secret and occult source, brancheth into innumerable channels, conveying health and relief wherever it is applied.'

Professor Röntgen came upon his marvellous X-rays—which have opened out new fields of research in physical science, besides being of far-reaching practical utility in surgery and other departments—quite by chance. He was experimenting in the dark with a Crookes vacuum tube, which was covered with some sort of cloth. A strong electric current was passed through it, while close by was some prepared photographic paper, but no camera. Next day he noticed several lines on this paper for which he could not account. By restoring everything to exactly the same condition as on the preceding day, he was able to ascertain the real origin of these mysterious marks. It is curious that Shakespeare should have written in *Hamlet:*

> Sit you down; you shall not budge;
> You go not, till I set you up a glass
> Where you may see the inmost part of you.
> *Act* III. *Sc.* 4.

There is a pathetic story, perhaps not generally known, concerning one who anticipated Daguerre,

Fox Talbot, and all other experimenters in solving the problem of fixing the fleeting image of the camera. While half the Academy of Sciences in Paris were struggling with the difficulty, a poorly-clad, half-famished-looking lad left a plate at the shop of Chevalier, the optician, on the Quai de l'Horloge, which proved that he had succeeded where all others had failed. He promised to return next day and show how the victory had been obtained. But from that hour to this he was never seen. Probably he fell sick and was buried in a pauper's grave, and the world will never know the name of the first professor of sun-picturing, or the details of its earliest romance.

'I was singing,' says Mr Edison, 'to the mouthpiece of a telephone, when the vibration of the voice sent the fine steel point into my finger. That set me thinking. If I could record the actions of the point and send the point over the same surface afterwards, I saw no reason why the thing should not talk. I tried the experiment first on a strip of telegraph paper, and found that the point made an alphabet. I shouted the words "Halloa! halloa!" into the mouthpiece, ran the paper back over the steel point, and heard a faint "Halloa! halloa!" in return. I determined to make a machine that would work accurately, and gave my assistants instructions, telling them what I had discovered. They laughed at me. That's the whole story. The phonograph is the result of the pricking of a finger.'

Though the examples here given by no means exhaust the roll of accidental revelation, they suffice to show that invention—to use the word in its now generally accepted sense—must be preceded by discovery, in the same way as production is a *sine quâ non* of manufacture. In each case nature provides the material, leaving the execution to the genius, art, and subtlety of man.

JOHN BURNET OF BARNS.

CHAPTER XXX.—I RUN A NARROW ESCAPE FOR MY LIFE.

THIS was in April, and now the summer began to grow over the land. The days grew longer and the air more mild, the flowers came out on the hills—little mountain pansies and eyebright and whortleberry and the first early bells of the heath; the birds reared their young, and the air was all filled with the cries of them; and in the streams the trout grew full-fleshed and strong.

And all through these days I lay close hid in the wilds, now in one place, now in another, never wandering far from Tweeddale. My first hiding was in a narrow glen at the head of the Polmood Burn, in a place called Glenburn. It was dark and lonesome; but at first the pursuit was hot after me, and I had no choice in the matter. I lived ill on the fish of the burn and the eggs of wild-fowl, with what meal I got from a shepherd's house at the burn-foot. These were days of great contemplation, of long hours spent on my back in the little glen of heather, looking up to the summer sky and watching the great clouds fleeting athwart it. No sound came to disturb me. I had few cares to vex me; it was like that highest state of being which Plotinus spoke of, when one is cumbered not with the toils of living.

In this place I abode till near the middle of the month of June. Twice I had gone to the cairn on Caerdon and left a letter, which I wrote with vast difficulty on fragments of paper which I had brought with me, and received in turn Marjory's news. She was well and in cheerful spirits, though always longing for my return. The days passed easily in Smitwood; and as none came there, she was the better hidden. I wrote my answers to these letters with great delight of mind, albeit much hardship. The ink in the ink-horn which I had always carried with me soon became dry, and my pen, which I shaped from a curlew's feather, was never of the best. Then after the writing came the long journey, crouching in thickets, creeping timorously across the open spaces, running for dear life down the hill-slopes, until I came at length to the cairn on Caerdon, and hid the letter 'neath the gray stones.

But about mid-June I bethought me that I had stayed long enough in that lonely place, and resolved to move my camp. For one thing, I wished to get nearer Barns, that I might be within reach of my house for such provisions as I required. Also, there were signs that the place was no longer safe. Several times of late I had heard the voice of soldiers on the moors above my hiding, and at any moment a chance dragoon might stray down the ravine. So, late one evening about midsummer, I bade adieu to the dark Glenburn, and took off across the wild hills to the lower vale of Tweed.

The place I chose was just at the back of Scrape, between that mountain and a wild height called the Pyke-stone Hill. It was a stretch of moss-hags and rough heather, dry as tinder at this time, but, as I well knew, in late autumn and winter a treacherous flow. Thither I had been wont to go to the duck-shooting in the months of November and February, when great flocks of mallard and teal settled among the pools. Then one has to look well to his feet, for if he press on eager and unthinking he is like to find himself up

to the armpits. But if he know the way of the thing, and walk only on the tufted rushes and strips of black peat, he may take the finest sport that I know of. Here, then, I came, for the place was high and lonesome, and with a few paces I could come to the top of the Little Scrape and see the whole vale of Tweed from Drummelzier to Neidpath. I had the less fear of capture, for the place was almost impassable for horses; also, it was too near the house of Barns to be directly suspected, and the country below it was still loyal and with no taint of Whiggery.

Here, then, I settled myself, and made a comfortable abode in a dry burn channel, overarched with long heather. The weather was unusually warm and dry, the streams were worn to a narrow thread of silver trickling among gray stones, and the hot sun blazed from morn to night in a cloudless sky. The life on the whole was very pleasing. There was cold water from a mossy well hard by when I was thirsty. As for food, I made at once an expedition to the nearest cottage on my lands, where dwelt one Robin Sandilands, who straightway supplied all my needs and gave me much useful information to boot. Afterwards he came every second day to a certain part of the hill with food, which he left there for me to take at my convenience. Hence the fare was something better than I had had in my previous hiding-place. Also, it was a cheerful life.

However, ere June had merged in July, I found myself in want of some companion to cheer my solitude. I would have given much for some like-minded fellow-wayfarer; but since that might not be had, I was fain to content myself with a copy of Plotinus, which I had got with all the difficulty in the world from the house of Barns. It happened on a warm afternoon, when, as I lay meditating as was my wont in the heather, a great desire came upon me for some book to read in. Nothing would do but that I must straightway set out for Barns at the imminent peril of my own worthless life. It was broad daylight; men were working in the fields at the hay; travellers were passing on the highway; and, for all I knew, soldiers were in the house. But with a mad recklessness I ventured on the quest; and entering the house boldly, made my way to the library, and was choosing books. Then I was startled by the noise of approaching steps, and seizing hastily the first volume I could lay hands on, I set off for the hills at the top of my speed. The visit had renewed old recollections, and I spent a bitter evening reflecting upon my altered position. Howbeit, those who seek it will soon find it in the book of philosophy which I seek soon to publish with Master John Herries, in the West Bow of Edinburgh.

But toward the end of October, when the nights grew long and the sunsets stormy, a change came over the weather. The Lammas floods first broke the spell of the drought, and for three clear days the rain fell in torrents, while I lay in my hole, cold and shivering. These were days of suffering and hunger, though I shrink from writing of them, and have never told them to any one. On the fourth I made an incursion down to my own lands, to the cottage of my ally. There I heard evil news. The soldiers had come oftener than of late, and the hunt had been renewed. The reward on my head had been doubled, and with much sorrow I had the news that the miller of Holmes Mill had been taken and carried to Edinburgh. In these dim, gray days my courage fell, and it took all the consolations of philosophy, all my breeding and manly upbringing, to keep up my heart. Also, it became more difficult to go at the three weeks' end to the cairn on Caerdon with the letter for Marjory.

It was—as far as I remember, for I did not keep good count—on the second day of September that I set out for Caerdon on my wonted errand. I had had word from Robin Sandilands that the country-side was perilous; but better, I thought, that I should run into danger than that my lady should have any care on my account. So I clapped the written letter in my pocket, and set out over the hills in a fine storm of wind.

I went down the little burn of Scrape, which flows into Powsail about a mile above the village of Drummelzier. Had I dared, I would have crossed the lowlands just above the village, and forded Tweed at Merlin's grave, and so won to Caerdon by Rachan and Broughton. But now it behoved me to be cautious, so I kept straight over the hills; and, striking the source of a stream called Hopecarton, followed it to where it joined the river in the Mossfennan haughs.

All seemed quiet. The stream, now changed from its clearness to a muddy brown, was rolling on its way through the fields of stubble. The few houses smoked in peace. The narrow road was empty of travellers. . . . Without hesitation I ran down the slopes, caring not to look circumspectly to the left and right. . . .

I had not run far till something before me brought me to a halt and sent me flat among the grass. Just below the house of Quarter, coming from the cover of the trees, was half-a-score of soldiers.

My first thought was to turn back and give up the project; my second, to go forward and find a way to cross the valley. Happily, the foliage was still there, the heath was still long, the grass was dense: a man might succeed in crossing under cover.

With a beating heart I crawled through the heather to the rushes beside a little stream. This I followed, slowly, painfully, down to the valley, looking sharply at every bare spot, and running for dear life when under cover of bank or brae. By-and-by I struck the road, and raised myself for a look. All was quiet. There was no sign of any man about—nothing but the beating of

the rain and the ceaseless wind. It was possible that they had gone down the vale, and were by this time out of sight. Or maybe they had gone up the water on their way to the moors of Clyde. Or still again, they might have gone back to the house of Quarter, which they doubtless loved better than the rainy out-of-doors. In any case they were not there, and nothing hindered me from making a bold sally across the open.

I rose and ran through the corn-field, cleaving my way amid the thick stubble. The heavy moisture clung to my soaked clothes and the sweat ran over my face and neck; but I held straight on till I gained the dry-stone dyke at the other side, and scrambled across it. Here I fell into the stream and was soaked again; but the place was not deep, and I was soon through. Now I was directly beneath the house, but somewhat under the cover of the trees; and still there was no sign of man nor beast. I began to think that, after all, my eyes had deceived me, and taken nowt cattle for dragoons. Such a trick was not impossible; I had found it happen before at the winter's shooting. With this pleasing hope, I straightened my back and ran more boldly up the planting's side till I gained the moorlands above. Here I paused for a second to enjoy my success and look back upon the house.

Suddenly something rang past my ear, with a whiz and a clap, and a voice behind me cried, 'Stop! Gang another step and I fire.' So the cup of safety was dashed from my lip at the very moment of tasting it.

I did not obey, but dashed forward to the high moors with all my speed. It was conceivable that the men were unmounted and their horses stabled, in which case I might get something of a lead. If not, I should very soon know by the clear, convincing proof of a shot in my body.

My guess was right, and it was some little time ere I heard the cries of pursuers behind me. I had made straight for the top of the ridge, where the ground was rough for horses, and I knew that they could not follow me with any speed. I was aye a swift runner, having been made long and thin in the shanks and somewhat deep-chested. I had often raced on the lawn at Barns with my cousin for some trifling prize. Now I ran with him again, but for the prize of my own life.

I cannot tell of that race, and to this day the thought of it makes my breath go faster. I only know that I leaped and stumbled and ploughed my way over the hillside, sobbing with weariness and with my heart almost bursting my ribs. I never once looked behind, but I could measure the distance by the sound of their cries. The great, calm face of Caerdon was always before me, mocking my hurry and feebleness. If I could but gain the ridge of it I might find safety in one of the deep gullies. Now I had hope; now I had lost it and given myself up for as good as dead. But still I kept on, being unwilling that any one should see me yield, and resolving that, if I needs must die, I would stave it off as long as might be.

In the end—after hours, or was it minutes?—I reached the crest and crawled down the other side. My pursuers were still some distance behind, and labouring heavily. Near me was a little ravine, down which a slender trickle of flood-water fell in a long cascade. I plunged down it; and, coming to a shelter of overlapping rock, crawled far in below, and thanked God for my present safety.

Then I remembered my errand and my letter. I clapped my hand to my pocket to draw it forth. The place was empty; the letter was gone. With a sickening horror, I reflected that I had dropped it as I ran, and that my enemies must have found it.

THE FUTURE OF ELECTRICAL ENGINEERING.

THE most striking feature of the recent developments in electrical engineering science to the lay mind is the ease and completeness with which the electric current can be converted into other forms of energy at will. The modern electrical engineer has indeed obtained a very remarkable command of this strange, elusive force that we call electricity, and in recent years he has given many noteworthy proofs of his progress in utilising it for the service of mankind.

It will no doubt surprise many of our readers to hear that these modern applications of electricity are in nearly every case based upon facts or laws discovered by Davy and Faraday three-quarters of a century ago. The discoveries of these two noted men in the realm of electrical science earned for them undying fame, but they did not lead at once to the practical application which many of their contemporaries had no doubt expected to see. Excepting in land and ocean telegraphy, progress was slow; and until the commencement of the eighties the practical applications of electricity outside the field of telegraphy were few in number and unimportant in character. Since the year 1880, however, there has been a most rapid development in many directions; and in the coming century electrical engineering, in the opinion of those well qualified to judge, is destined to occupy a position of supreme importance. In order to enable our readers to understand the progress of the past fifty years, and to form an independent judgment concerning the hopes of the future, we shall give in this article an

explanation in non-technical language of those applications of electricity to the affairs of daily life that may be seen in our towns and cities at the present moment. In electrical science, as in other things, correct knowledge of the present is the most certain basis upon which to build judgment of the future.

If the various practical applications of electricity in the world about us be carefully scrutinised, they will be found to fall into three broad groups or classes. In the first will be found those applications depending upon the conversion of electricity into mechanical movement; in the second, those applications depending upon the conversion of electricity into heat; and in the third will be gathered those depending upon its conversion into chemical activity. Let us now examine these in detail.

Faraday, in one of his most notable experiments, discovered that if a piece of copper wire be bent into a closed ring, and be moved to and fro in the vicinity of a powerful magnet, currents of electricity flowed through the wire ring. These currents are called 'induced currents.' Repeating this experiment in another form, he found that if a light magnetic needle be suspended in the centre of the copper wire ring, and an electric current be passed through the latter, movement of the needle occurred. From these two comparatively simple experiments have sprung all those applications falling into the first group—that is, depending upon the conversion of electricity into mechanical movement.

Land and ocean telegraphy were the earliest practical applications of these principles; and it is instructive to note that it is only within the last fifteen years that the 'Society of Telegraph Engineers' has changed its title to the broader one of 'Institution of Electrical Engineers.' Telegraphs do not demand large currents of electricity; to this fact their early development was no doubt largely due.

A second application of small currents of electricity was perfected in the eighties—namely, the telephone. Twelve years ago this instrument was a novelty except in scientific circles; to-day it is an almost indispensable adjunct of business and social life. A perfect network of overhead wires in all our cities and manufacturing towns bears witness to the importance and extent of the telegraphic and telephonic systems. The first step in opening up all new countries is to erect a telegraph-line, and the telegraph-post has become one of the most infallible and most visible signs of civilisation. The world is now invested in a meshwork of cables and land-lines continually growing in extent and complexity; and through the operations of these it has become, in its social and political aspects, singularly subject to nervous shocks. In spite of this drawback, the telegraphic and telephonic systems will continue to grow, for their utility is unquestioned. The branches of electrical engineering connected with these two developments will therefore expand, and the progress in the future may certainly be expected to rival that of the past.

To turn now to other applications of the same experimental truth—that mechanical movement of coils of wire in the neighbourhood of powerful magnets produces electric currents—we find that the dynamo and the electric motor are both based upon this same principle. These appliances are, in fact, closely related to the telegraph instrument and to the telephone; their chief distinction lies in the magnitude of the currents which they produce or utilise. The dynamo is the machine by which mechanical motion is converted into electrical currents on a large scale; the electric motor is the machine which performs the opposite service. It is owing to the invention and perfecting of the dynamo that many of the more recent applications of electricity have become possible; for, while chemical batteries were the only source of electrical energy, the cost of the current rendered such applications wholly impracticable. In the past the chief use of the dynamo has been in connection with the electric lighting industry; but in the more recent developments of electric traction and of power-transmission upon a large scale the dynamo is also a most essential element of success.

For traction purposes the dynamo is used in conjunction with the electric motor. At some centrally-situated spot the boilers, steam-engines, and dynamos are set down, and the current generated here is carried by overhead or underground conductors to the tram or railway car on which it is to be used. For street vehicles this plan is impossible, and the current has to be passed into what is called a 'storage battery' carried by the vehicle itself. In all cases where motion is required, the current is allowed to pass through the electric motor with which each type of vehicle is provided, and the revolutions of the motor are then communicated by means of suitable gearing to the wheels of the vehicle. One of the earliest electric railways was erected by Messrs Siemens at the Giants' Causeway in 1883. A considerable number of schemes have been carried to completion in this country since that year; but the development has been slow compared with that witnessed in Germany and America. The advantages which especially fit electricity for use in cities and towns, as the propelling power for street vehicles, trams, and railways, are the freedom from smoke, foul gases, or dirt, and the facilities which it offers for attaining a rapidity of transit impossible by the present methods of propulsion. It is therefore not surprising that electricity is rapidly growing in popular favour for purposes of city traffic; and in fifty years (many would assert in a much shorter period) it is doubtful whether it will be possible to find in any city of Europe or America either trams or city railway cars propelled by horse or steam power. The city cab and bus horse will also give place

to this new propelling agent; and the fact that four electric vans have already commenced to run between the G.P.O., London, and the district sub-offices indicates still further displacement of the faithful horse. Electricity has therefore a very wide field of usefulness open before it in connection with the transport of men and merchandise in cities; and those branches of the electrical engineering business dependent upon this development will be kept busily employed for many years to come.

The dynamo and electric motor have also appeared in yet another domain of activity, and present indications point to a considerable growth in this direction in the future. The transmission of the power developed by the steam-engines in large mills and factories to the various points where it is utilised has in the past been effected by mechanical means. Long shafts and belt-gearing, however, entail great loss of power; and there is now a decided movement in favour of electric transmission. This is effected as follows: the energy developed by the engines is converted into electrical energy by means of the dynamo; copper conductors are then used to convey the electric current to the different points where the power is to be used, and electric motors of various sizes reconvert the electrical into mechanical energy at the moment and for the period it may be required.

This method has been adopted in many engineering works in Germany and America, and its introduction into this country has already occurred.

The still more extended applications of the method in connection with the development of power from falling water has been noticed in an article in the January issue of this *Journal*, and from wind in the article 'The Wasted Wind' in the April issue.

Faraday's simple experiment connecting mechanical movement and electrical energy has therefore received marvellously wide and extended application; for telegraphs and telephones, electric trams, railways, and cabs, and schemes of power-transmission in factories and works, are all the direct outcome of this experiment made nearly three-quarters of a century ago.

In the second group of the applications of electricity are found those depending upon the conversion of electricity into heat.

The laws governing the relationship between electricity and heat were discovered by Faraday and Ohm; but there is no doubt that Davy had noticed, in his electro-chemical experiments, that while platinum was heated to redness by the electric current, copper remained under similar conditions comparatively cold. All applications of electricity to lighting or heating purposes are merely developments of the facts and laws discovered by these noted investigators early in the century. In the small incandescent lamp the electric current is allowed to pass through a carbon filament, which is heated in consequence to whiteness. If air were present the filament would quickly burn away, but by enclosing it in an hermetically sealed glass bulb and exhausting the air, the combustion of the white-hot filament is avoided. In the arc lamp the air takes the place of the carbon filament of the incandescent lamp, and the obstacle—or 'resistance,' to use a technical term—imposed by the air-gap between the points of two carbon pencils is the direct cause of the dazzling chain of carbon particles that is carried by the current across the gap.

In the electric furnace, the 'resistance' of the materials which are to be heated is sufficient in many cases to produce the heat required when the electric current is made to pass through them. In other cases the electric arc is used in the furnace, since its temperature is higher; for dry air offers a greater 'resistance' to the passage of the current than any solid materials.

With regard to the past growth and present developments of these applications of electricity, the electric lighting industry, as the oldest, of course stands in the forefront. It is difficult at times to realise that only fifteen years ago the electric light was more or less of a novelty. To-day every city and town of any pretensions in both the New World and the Old is provided with the electric light, and the number of users of electricity for lighting purposes is rapidly growing. As in the case of electric traction and power-transmission, it is chiefly the convenience and simplicity of the method of use that is favouring the adoption of electricity as a lighting agent. The cost is still higher than that of gas or oil; but as the number of consumers increases the cost will fall, and this is an influence that is already making itself felt in winning new customers in many towns. The electric lighting industry will therefore undoubtedly continue to grow.

Though electricity as a heating agent is much more expensive than coal or gas, the practical applications of electricity for heating purposes are increasing in number. Two advantages balance this greater cost: the intensity of the heat obtained, and the wonderful convenience of its application. In the electric furnace temperatures can be obtained that are unattainable by any of the older methods of heating, and two manufacturing industries have been founded upon this use of electricity. Carborundum and calcium carbide, products of the electric furnace, cannot be made on a large scale in any other way. Electric welding is another application of electricity in which effects are obtained that cannot be arrived at by ordinary methods. Here the localisation within a small area of a very intense heat is desired, and the electric arc, or the heat produced by the local 'resistance' of the metal to be welded, is made use of to create the required welding temperature. Electricity as a heating agent for domestic use has not made a great advance, although here again its convenience is much in its favour. The last hotel erected in New York has,

however, been fitted throughout, as regards the bedrooms, with electric heating appliances; and such diverse ends as heating curling-tongs, frying pop-corns, and airing the bed, can all be effected by the mere insertion of plugs into sockets in the walls. Electricity as an agent for producing heat has therefore already attained a fairly wide field of utilisation, and progress in the future is certain to occur.

In the year 1807 Davy was experimenting in the laboratory of the Royal Institution, London, upon the action of the electric current when passed through fused salts, or solutions of the same. It was during these experiments that he discovered the alkali metals potassium and sodium, and raised himself to a position of pre-eminence among the chemists of Europe. The practical applications of Davy's discoveries relating to electro-chemistry, as in the case of those of Faraday relating to light and heat, were long delayed, owing to the absence of any cheap source of electrical energy. With the advent of the dynamo, electroplating and electrotyping developed into extensive minor industries. Electroplate is everywhere in evidence; and this manufacture is certainly one of the most useful and successful applications of Davy's and later workers' investigations concerning the deposition of metals by the electric current. It is not so generally known that electrotyping is an equally important industry. In the printing trade the preparation of electrotypes is one of the chief features of the quick methods of reproduction now employed, and many of these methods would be impracticable were it not for the ease and convenience with which exact replicas of printers' and engravers' blocks can be obtained in the electrolytic bath. Still more recently the development of water-power for industrial purposes has led to a great reduction in the cost of electrical energy, and a large number of electro-chemical industries, based upon the principles discovered by Davy over eighty years ago, have sprung into existence. The mere enumeration of the metals and chemical products that are now being manufactured by these new processes in Europe or America upon an industrial scale will serve to show how wide a field of usefulness has been opened by the labours of electro-chemists and electrical engineers. Aluminium, antimony, chromium, copper, gold, magnesium, nickel, potassium, silver, sodium, zinc, phosphorus, ozone, alkalies, bleaching-powder, bleaching-fluids, potassium chlorate, galvanised iron, and numerous organic products are all being produced by processes in which electricity plays a part at the present time. These new methods of production are in many cases highly successful, and the older methods of manufacture have already disappeared, while in others such disappearance is only a question of time. Though it is possible that some of the manufactures included in the above list may not survive the test of commercial trial, electro-chemistry is undoubtedly one of the most promising branches of applied electrical science, and its growth and expansion in the future are assured.

This review of those applications of electricity that are actually accomplished facts—not mere visions of the future—proves that electricity in the hands of the electrical engineer will occupy a foremost place among the applied sciences in the coming century, for its sphere of action will embrace every department of our social and industrial life.

A MYSTERY OF THE SWORD.

PART II.—CONCLUSION.

'YOU will have perceived the points which struck me as curious in this interview. For one thing, Stuttgart is not within the kingdom of Bavaria. For another, this person had learned my identity with *sang froid*. Now I not only flattered myself that my reputation had penetrated into Germany, but I had good reason to be aware of the notorious fact that nowhere in the world is the law of caste so powerful as amongst the arrogant nation we have such deep cause to hate. Yet only on second thoughts had it occurred to M. von Stulbach that my social standing was not sufficiently high to afford me the honour of crossing swords with an aristocrat—such as a Von must needs be over the border.

'On the next day it was rumoured that Von Stulbach had ceased to show himself in public, and in the evening the corner table at the café was without an occupant. Some said he had left Paris, others that he passed the entire day fencing in one of the schools; but Hallard declared that he had seen him in the Bois in the course of the morning.

'Immersed in speculations, I awaited the reply to my telegram with impatience.

'Meanwhile M. le Capitaine haunted my *salle-d'armes*, and practised diligently, but without making any progress. As far as I could judge, his adversary had but to protrude his sword and my pupil would inevitably impale himself upon it.

'On the eve of the decisive morning I asked my client if he had provided himself with a second.

'"You smile, monsieur; but pardon me if I say that your countrymen consider but slightly the conventionalities of societies other than their own.

We of the Latin races are not too self-centred to adopt all that we see of good in your institutions. For instance, we admire your methods of sport, and follow them; we appreciate and patronise your tailors of London. But your nation is more narrow and self-satisfied. You care to annex nothing outside your own shores—except, perhaps, continents!"

'Captain Brerliam replied that a friend was coming over from England that night to act for him.

'"You seem to have seen Von Stulbach," he added, "but can gather nothing about his antecedents. Is it not odd that he should be so completely unknown? Well, as I said before, I am out of my depth in this affair. Good-bye. If I live until to-morrow I'll look in and tell you what happened."

'He swung out of the door, his sunburnt face working, and repeating "till to-morrow," as if it were with me and not with the German that the quarrel lay.

'During this interval I had in private been perfecting myself in certain coups of which I alone possessed the secret. From my standpoint it was difficult to forecast the future. Up to the moment when I parted from M. le Capitaine I had received no reply from Stuttgart. I almost despaired of gaining the information I had hoped for, but it came at a late hour, and proved to be of a most explicit nature.

'The duel was to take place in the park of St Ouen; and, acting on my advice, my client went down with his second the night before and slept at an inn in the vicinity.

'Therefore, to reach M. le Capitaine before the encounter, I rose at dawn, and having partaken of a cup of coffee, I proceeded by the earliest train to St Ouen. I kept a lookout for M. von Stulbach's party, but saw nothing of them.

'Alighting on the platform in a shower of drizzling rain, with the signals and doors shaking in the cold wind from the river, I made haste to the inn, where I found myself well in advance of the appointed hour. Being informed that the Englishmen were not yet risen, I took upon myself the duty of awakening M. le Capitaine.

'After knocking at the door I entered.

'"Time to get up? All right!" he growled; then rousing more fully, he recognised me. "Hullo M. Desterre! Anything wrong?"

'For answer I begged to be allowed to address the gentleman who was to act in the interests of M. le Capitaine.

'"He's in there," replied Captain Brerliam, indicating a second door. "But if there's anything in the matter you can tell me"——

'I began to explain that I should prefer—— when the door burst open and a young man rushed headlong into the apartment.

'"Time, old man! Up you get! You've got to stick the Doitcher"—by which name he throughout continued to allude to M. von Stulbach—"in less than an hour—I beg your pardon—— But who the dickens is this?"

'"May I have the honour of a word with you, monsieur?" I interposed, adding an intimation as to who I was.

'"Right you are, sir!" exclaimed this gentleman. "You'll excuse me—early hours, you know—and it's cold. Come along."

'With that he preceded me into the adjoining room, where he requested me to sit down, while he scrambled back into bed, clasped his hands round his knees, and professed himself ready to listen.

'"By-the-way, my name's Guspitt," he added.

'Then I informed this M. Guspitt of certain facts. At the end of my recital he sprang from his bed.

'"You're a fine fellow, sir," he cried—"a deuced fine fellow! And if ever you should want a friend in any way, I beg you will apply to James Guspitt, barrister-at-law."

'Upon this the impulsive young man seized my hand and inflicted upon it a pressure I did my utmost to return; though, indeed, my fingers felt somewhat paralysed by the stress of his gratitude.

'"Shall we leave this Doitcher to cool his heels?" he demanded, drawing up a blind.

'"I think, monsieur, we must appear on the field. An interview is at least advisable."

'"Of course, of course! I'll interview him at the end of a cane, sir!"

'I realised that such an interview might be unpleasant, for I, who am a judge of men, saw the muscles jump out on his arm.

'"It grows late, monsieur," I said, "and your friend must start shortly."

'"I won't be half-a-minute," he responded.

'And, in effect, as I left the room I heard this grampus of a man plunging and splashing in a bath of icy water.

'In a short time they joined me at breakfast, M. Guspitt having recommended something more solid than coffee and rolls to fight on that cold morning.

'Captain Brerliam was inclined to silence, M. Guspitt continually urging him to decapitate the Doitcher, and laughing when I endeavoured to explain that such a course would be impossible.

'When we rose M. le Capitaine grasped the hand of M. Guspitt.

'"I'll pink him all right, old chap," he said; then turning to me, he continued: "M. Desterre, I am infinitely indebted to you for all you have done. As to repaying you—why, that may be the affair of my executors."'

Then we stepped out and walked quickly into the park. The morning had improved, and it was fine overhead, though the wind still blew sharply from the north. I need not describe the spot to you, monsieur. You know it—the little, level sweep of grass behind the thicker-growing trees close to the river-side.

'On coming round this belt of woodland we per-

ceived M. von Stulbach, dark-browed and sullen, already on the ground with his second. They were pacing up and down. At sight of us the second advanced. M. Guspitt detached himself from us to meet him.

'After the usual salutations the other said in a loud tone:

'"You are late, monsieur! Shall we place our men?"

'The words were unmistakably meant to reach the ears of Captain Brerliam, and were calculated to incense a person of his hasty temper. This in itself was an offence of an unpardonable nature.

'M. Guspitt smiled.

'"I shall have great pleasure in kicking your man, sir!"

'I stepped forward to interpose. Captain Brerliam stood appalled.

'"Guspitt!" he cried, frowning.

'But M. Guspitt had placed himself facing Von Stulbach.

'"Yes, I shall deal with you, sir," he exclaimed threateningly.

'"Afterwards, monsieur, afterwards—with pleasure," replied the German, with a sneer. "But first I must finish my affair with your principal."

'"There will be no 'afterwards,'" cried M. Guspitt. "Any affair will be with me, and of a very different sort to that you propose with Captain Brerliam. You're known, sir!"

'I, who was watching the face of the German, saw it contract slightly.

'M. Guspitt, turning to his friend, went on:

'"If I were you I'd flog him, Brerliam."

'Meantime the German's face flamed, while M. le Capitaine gazed from one to the other in amazement.

'"Stand back!" shouted the second of Von Stulbach, coming between them. "You cannot withdraw from the encounter now. All this mad bluster is useless."

'M. Guspitt spoke more collectedly.

'"It is impossible that this duel should take place. Brerliam, this man is not Von Stulbach, as he calls himself, but Worsen, a fencing-master of Stuttgart, hired to do the work of an assassin! We owe the discovery of the plot to M. Desterre."

'"Is this so?"' said M. le Capitaine.

'"Of course it is!" exclaimed M. Guspitt. "Otherwise would I be saying it?"

'"M. Brerliam is over ready to believe these absurd statements," remarked Worsen—as I must now call him—with a disagreeable accent.

'"We have ample proofs," I hastened to say.

'Captain Brerliam wheeled round and stared in the countenance of his adversary; then he uttered one of his big, sudden laughs.

'"Do you want a proof? I can give you one, then!" and with a swift movement he plucked the beard from Worsen's face. "Who put this new courage into you, man? You had no stomach for our last meeting at Berlin?"

'Then he advanced upon him with an aspect of fury.

'"I've a mind to give you a good hiding! Who sent you?"

'Worsen shrank back, but remained silent. We of the continent of Europe are not fond of the *jeu de mains*, as are the English. Besides, I have often observed that a man who will face a danger to which he is accustomed with coolness loses his nerve when confronted with one that is strange to him. Now, I had no doubt whatever that Worsen, though perfectly ready to meet the blade of the first swordsman on earth, had been unable to bring himself to look at death down the pistol-barrel of M. le Capitaine, nor at this moment could he endure the indignity and suffering of a hammering by the fists of this big Englishman. I felt for him, monsieur; I felt for him, in spite of all.

'The man of Stuttgart turned to me.

'"I owe this to you," he said harshly. "From you at least I can demand reparation."

'"Will you leave this matter in my hands, M. le Capitaine?" I said. "Nevertheless, M. Worsen, I believe I could, under the circumstances, refuse to meet you."

'Worsen sprang forward and struck me lightly on the chest.

'"Coward!" he exclaimed. "I knew it!"

'"You have already said so twice," said I.

'"I will proclaim it to all France," he cried, "if you continue to refuse me satisfaction."

'"There will be no need," I returned quietly. "We must meet for our individual honour and the honour of our respective nations!"

'"No, no, Desterre! this is my affair," broke in Captain Brerliam.

'"Leave it alone!" said M. Guspitt, taking him by the shoulder. "Your affair is with the master, not with the servant. And I should advise you, M. Desterre, to have nothing to do with this rascal either, He is unworthy of your sword."

'And that, monsieur, is the story of Captain Brerliam's affair.'

Desterre raised his glass and drained it. The murmuring silences of the summer night closed in upon his voice.

'Then you had a meeting with Worsen?' I asked at length.

'But, yes, monsieur. Ah, there was talk and enthusiasm in Paris about that affair! For I had a reputation then. Personally I was enchanted; he was a swordsman of the first rank. Nevertheless he lacked something—good fortune, perhaps. I had the luck to pass my rapier through his shoulder. My friends and clients held a fête in my honour. But those days are gone for ever! Everything passes, monsieur; everything passes!' he ended sadly.

'And what of Captain Brerliam?'

'He achieved his wishes; he united himself with the beautiful Countess. One can guess that he made capital out of the affair of Worsen to force

the brother-in-law to see reason—eh? I saw him at Mont St Michel three years ago. He is redder and more sunburnt than ever, but he carries always the same fascination. He and Madame did me the honour to invite me to dinner.'

By this time we were walking down the quiet, white road barred with shadows. Desterre, his head on his breast, had returned in thought to the brilliant days in Paris, for as we parted he said, 'Ah, monsieur, I had a reputation then!'

A SCOTCH TEACHER IN NEW YORK.

WHEN I landed in New York, about three years ago, I had no extravagant expectations of getting immediate and lucrative employment; and yet I was not prepared to find it so difficult to get placed. The objection to employing me—one which I met at every turn of the way in the first few months of my quest for work—might be formulated as follows: 'You appear to have the qualifications necessary for the position, and personally you would be acceptable to me; the only fear I have arises from the well-known fact that American boys are so unlike English boys, and require different methods of discipline.'

I first tried a well-known school agency in New York, which sent me several notices of vacancies in out-of-the-way places. For the nearest of these I applied by letter—it was in a ladies' college in Virginia; but, convinced by the lady principal's answer that what she really wanted was a sort of spiritual overseer and factotum, rather than a plain teacher of the humanities like myself, I dropped the negotiation and paid no further attention to agency vacancies.

At last, through persistent watching of the advertising columns of the leading newspapers, I did succeed in getting a position in New York as teacher of classics and mathematics in a school of about fifty boys. It was a preparatory or secondary school, and as it was not a boarding-school, I congratulated myself on being well rid of the galling burden of playground and domestic supervision under which I had so long chafed in England. I may here mention that, after graduating in Arts at the University of Edinburgh, I had taught in a Scotch school for one year; and then, after some months of private tuition, accepted a situation in an English boarding-school, where the salary, exclusive of board and lodging, amounted to sixty pounds a year. My salary now was to be seven hundred dollars (about £140), a figure which many American teachers would have turned away from, but which my circumstances did not permit me to decline.

As I have said, I had been repeatedly warned of the difference between American boys and British boys; and certainly, if their conduct in the home, and especially in the street, was to be taken as the criterion, the difference is patent to any observer who keeps his eyes open. But when I came to meet them in a well-ordered school—such as this one undoubtedly was—I found no such radical differences as had been predicted. Americans are too ready to assume that English boys are tyrannised over at school, and that no such pleasant relations as often obtain in their country between teacher and scholar can exist in a Scotch or English school. It is as difficult to convince them of the contrary fact as it is sometimes to make them believe that members of parliament receive no pay for their services. At any rate, I found it no such hard matter to manage a class of sixteen well-grown American boys; indeed, they proved, as a rule, to be not only apt and intelligent at their work, but remarkably attentive and respectful in their deportment as well. There was not a really troublesome boy in the whole lot, the only source of embarrassment being a chubby-faced youth of German stock, who had a turn for practical joking, though he weighed about 250 lbs.

About half of my class had passed through the regular course of the school from the primary department up to the graduating class. These were pretty well grounded; but the class as a whole would not have attained to a satisfactory standard if tried by a British test. One thing I considered largely to blame for the shambling, unsolid character of these boys' performances was the absurd system of marking up for lessons in vogue in the school. An average of 90 per cent. was what everybody looked for, while 60 per cent. was downright failure; and when a boy got a succession of low weekly averages he was very apt to take the huff, and by-and-by he might be heard of as attending some other school.

My boys were handicapped in still another way. Some time before Christmas they were set to 'memorising' orations, dialogues, and passages of Latin and Greek for recitation at the annual entertainment to be given by the school before closing for the holidays. Of course it resulted in their proper work being performed very perfunctorily, when it was not neglected altogether. When the great day, or rather evening, arrived, and the first part of the programme had been successfully rendered, the principal ascended the platform, and, making his bow to the packed audience, read off from a report-book a few details regarding those precious averages, which

seemed to be assumed by everybody to be exactly commensurate with the proficiency of the pupils.

Still another and most serious thing interfered with the efficiency of the class. There was no rigid and impartial examination awaiting it at the end of the session, to put the boys on their mettle, as is the effect on an English school by the approach of the emissaries of the Oxford and Cambridge Schools Examination Board; or as used to be the case in Scotland, in my earlier days, when the event of the year was the examination of the whole school by a deputation of the ministers of the presbytery, whose faces loomed fatefully on that morning behind a pile of glittering prize-books on the master's desk. Here the examination of my classes was to be conducted by myself, under the general supervision of the principal, at the end of the school year in June, or the end of May. In the public schools, of course, a much more rigid and effective system prevails, the examinations in them being periodically conducted by the Superintendent of Public Instruction and his staff of assistants.

Long, however, before our 'commencement' day arrived—that is, the day for the final exercises of the school, when the public were again admitted—a whispered rumour had been going the rounds of the older teachers, which, when it reached my ears, sent a cold thrill down my spine. It was to the effect that, owing to causes which had been at work for some time back, the school was not paying, and that some of us would have to go without our last two months' salary. To pass over this miserable experience, I must do the principal the justice to say that he showed a creditable feeling for me in my hard position, without money or friends in a strange land, by recommending me for some other work, which, though not of a very congenial nature, stood me in good stead during the long and trying summer months—that sweltering, dusty, noisy season in American cities, when to the forlorn Britisher, unable to leave the scorching city, life seems not worth living.

I declined to re-engage with this principal for the following year, even with the bait offered of an increase of salary (that might never be forthcoming), preferring to try for what I could get in the way of private teaching. After many failures in this direction, I at last struck out a form of advertisement which soon brought me plenty of pupils—of a kind. It might be amusing, but not profitable, to expose the pecuniary value of a tutor's services, as estimated by many worthy people. In America the teacher in a good school gets much more than he does in the average school in Britain; but when it comes to private tuition, conditions seem to be reversed, and the reason, or at least the chief reason, is not far to seek. The public school in America takes a good deal of the ground from under the feet of the private teacher, because it not only imparts an elementary training to the children of all classes who choose to avail themselves of it, but it also largely serves the same purpose as the middle-class secondary school of Great Britain. In America one has to go up a step or two in the social scale to reach people with the means for employing private tutors. The possession of such means implies also a certain degree of culture; and consequently a private tutor is better off in America than could be expected in a country where the influence of a public school system extends to almost every rank of the community. As it is, large numbers of people, intelligent but not particularly cultivated, have means enough to hire private teachers for special purposes, at rates more directly dependent on the general trend of business than is the case in England and Scotland. And there is no such demand for the services of the private teacher in the United States as there is in Britain in connection with the competitive examinations for the various branches of the Civil Service, as well as for the preliminary examinations of certain professional bodies. Civil Service reform is still in its first stages in America, and it is questionable, under the present system of government, if its principles can ever be very generally put in practice.

It was among this large and thriving class of citizens that my work now lay for some time, and my most pleasant memories date from this intercourse, for several of my patrons were not only satisfactory pupils (adults) in a twofold sense, but also extremely sympathetic and companionable as fellow-sojourners in this vale of the teachers and the taught. I had pupils of every age above childhood, of both sexes, and of almost every European nationality and condition of life. I prepared young men for college entrance examinations, and brushed up squads of young clerks in their grammar and arithmetic, but could never get them (or my young lady pupils either, fluent and stimulating as they might be in their talk) to write down their thoughts in simple, idiomatic English. I read Latin with patient and reasonable lawyers—who almost invariably make satisfactory students—and German with testy and unreasonable physicians, who, in their burning impatience to be put in the way of reading the German medical periodicals, required of their teachers an exercise of power which they would have called miraculous if demanded of themselves by their patients. I taught heads of families their (English) letters, and gray-beards the extraction of the cube root and the solution of triangles. And almost in every case I found the foreign-born pupil, or the pupil born of foreign parents, whether German, or Swede, or Irish, or Cuban, or South American (I had none British), to be both brighter and more persevering than the descendants of long-established American ancestry—a fact to be accounted for by the anthropologist and not by

the teacher, who must take men as he finds them in that seething caldron of the nations henceforward to be known as Greater New York. The chief faults of those of American descent, especially of young men in business, who came to me to be intellectually groomed were engrossment in social dissipation and 'raw haste, half-sister to delay.' They were amiable and even-tempered to a degree, but fickle and easily discouraged; even those of them with more backbone than the average were at the bid of every call of pleasure, or too impatient of results from their work. The heritage of even a go-ahead temperament is not without its disadvantages, as enlightened Americans will readily admit.

As I had many excellent pupils whom I shall always hold in pleasant remembrance, so, as might be expected, an indiscriminate fisher such as I was must sometimes have netted strange fish. On the principle of *ex pede Herculem*, I shall give an instance or two of these.

A young man wanted very badly to enter Harvard University in the following fall term—it was March when he came to me. Accordingly we set to work, reading *Cæsar* first; but when he had glibly rattled off the first few well-thumbed pages of his book and emerged into pastures new, his eagerness oozed out, and he collapsed. On my reporting this discreditable breakdown to his father, who was a commercial man, I learned that the boy's sole ambition in wishing to go to college was to shine as a member of one of the athletic societies, of which, it appeared, his elder and more gifted brother was already a distinguished ornament. A tip-top university stamp for his muscle was all the young jackanapes was after; but, unfortunately for his aim, his pluck was not equal to his ambition, and he returned to his desk in his father's office, to the no small satisfaction of the latter, who doubtless felt he had done his part in surrendering one son to the Moloch of college athleticism.

One day a tall, stylishly-dressed young person came to me on somebody's recommendation, and was not long of letting me into the secret that she had leanings towards a career on the stage. She wished, before entering a school of acting, to read portions of the English drama under my guidance, with the view both of making some acquaintance with the literature of the stage and of improving her pronunciation. She spoke with a strong German accent, appeared to be very illiterate, but also very positive and self-sufficient. I took down the comedy of *She Stoops to Conquer*, to test her reading and expression, and when she had floundered through a scene or two in an execrable manner, she suddenly asked me to explain the meaning of the title. But my explanation fell flat: the two notions of 'stooping' and 'conquering' were so incongruous to her mind that she could not bring them together in consciousness. Such dense, 'yellow-primrose' literalness of intellect I never met with in any human being before or since.

Another time I was visited by a robust-looking man in the prime of life, who stated that he was a master plumber, and that, being deficient in his arithmetic, he was finding it difficult to keep track of his bookkeeper's accounts, now that his business was increasing. A little fencing, however, elicited the pitiable admission that he was totally unable to read! He could read figures, add a little, and just write his own name—all he had ever learned in his native country—the Green Isle; but though he had hitherto been successful in concealing his limitations from the people about him, certain circumstances had recently given him the alarm, and he had made up his mind to try and mend matters. And what a struggle was his! What pathos in his groping efforts to spell out his way through the primer which his own little son had thrown aside two years before! But night after night, summer and winter, he kept it up, until at last he had his reward, and he could look his little boy boldly in the face, and had no more fears of his bookkeeper.

At one time I had a class of young French-Swiss watchmakers in Brooklyn, who deluded themselves into thinking that they would learn English from a teacher while living clannishly by themselves in a boarding-house where not a word of English was spoken. They were very good, jovial fellows, and sometimes great fun as well; but they took up their daily lesson as if to speak any language but their own was a humiliation to them.

Perhaps the oddest pupil of all was an old man over seventy, a native of Alsace, who wanted to learn geometry, because, after vainly trying to satisfy his craving for knowledge by dabbling in history and philosophy and even modern science, he had come to the conclusion that the only truths which could satisfy a rational mind were the truths of Mathematics! Yet, paradoxical as it may seem, but is not, this arid-minded old fellow, who found even the bald statements of modern science too flowery for his taste, was a religious man, and a churchwarden to boot. Alas! he turned out to be not so single-minded as he appeared. He had his adamantine crotchets, which I, backed by Euclid with chapter and verse, was powerless to remove. He ended his lessons, which had gradually degenerated into ill-tempered altercations with his teacher, by one day breaking out into a savage tirade, not against the equator, but against the Proposition of the Three Squares (Euclid I. 47), and I saw him no more. It was his Waterloo.

But though, sometimes, I had a good run of pupils, the work was poorly paid, when the cost of living was taken into account. A single man who 'sets up for a gentleman' cannot live decently in New York under two pounds a week; and

when it is stated that the average compensation for private teaching is no more than half-a-dollar (two shillings) a lesson—only the fortunate few getting from three to four shillings—it is easy to see that a tutor must be kept very busy indeed to leave any margin beyond a mere livelihood. And there are those three dreadful months from the middle of June to the middle of September to be considered and provided for, when New York is a Sahara to the unfriended foreign teacher.

A TUNISIAN TUNNY FISHERY.

SIDI DAUD, where the fishery is, is about forty miles from Goletta by sea, across the Gulf of Tunis, and something over sixty by land. The journey is generally made by sea, as the road is bad; although it can be done on horseback in eighteen hours, it, as well as the majority of the roads in the regency, is quite impassable for carriages.

Leaving Goletta, the port of Tunis, twelve miles from the capital, the traveller embarks in one of the native lighters—a two-masted lateen-sailed craft, destitute of cabin or any accommodation other than a seat on the cargo. With a good wind, Sidi Daud is reached in about four hours. As Goletta fades away the islands of Zembola appear in sight, where the usual track of ships is left, they turning to the left past Cape Bon. The larger of these two islands is inhabited by three or four Sicilian families, who bring the later days of Defoe's hero vividly to mind. Each family lives in a one-roomed stone house, guiltless of mortar. Goats abound, and the islanders milk them to make cheeses, with which, now and again, they venture in the rickety tub owned by the community on a voyage to Tunis—the whole of the male population, four men and a boy, acting as crew. The island simply consists of two mountains covered with a good deal of scrub. It was evidently thought a good point of fortification by the ancients, for it is covered with the ruins of what were once substantial structures. The smaller island adjacent is inhabited solely by gulls and by rabbits, which latter do not breed on the mainland, being at war with the jackals, or perhaps it is the jackals who are at war with them.

Some way out is a reef under water, which forms the port of Sidi Daud. It is thought to have been an ancient breakwater. The whole bay answers to a description in one of Virgil's *Eclogues*. In bad weather boats cannot make the port at night, and have to run to Hammam Corbus for shelter. In the seventies the *White Sea*, of 1000 tons, went aground here. The captain refused the help of a crew from the fishery, thinking that they were pirates, and the vessel was totally lost. A French vessel also went ashore there, but eventually, although deserted by all her crew except the captain, mate, and chief engineer, got safely off.

The boat plying between the fishery and the town belongs to a man named Tita, who has a contract to buy as many tunny after each haul as he likes at fifty piastres a hundred kilos (220 lbs.). A piastre or real is there worth sixpence. Tita also serves as post, as he makes fairly regular weekly trips. Whenever he carries any one from the family owning the Tonnaro, or letters, he hoists a flag of which he is very proud—Corriere di Sidi Daud.

When Tita draws up alongside the jetty at the fishery, the visitor is met by the heads of the island, the whole of which is appropriated to the fishery, forming a little kingdom of its own—the Capitano, his son (captain of the fishery steamer), Padre Paulo the priest, and the Doctor. The Padre, of course, represents the church and the Doctor science; and, as has happened in bigger communities, the two are a little at loggerheads.

Going up the town past the seamen's quarter, the principal rooms face what is called the Piazza, and are on the second story. As in all native buildings of any pretensions, the rooms surround an open space or patio on to which they all open; each division consists of two rooms, an outer lobby and a bedroom. In addition to the bedrooms, there is a dining-room, kitchen, store-rooms, and a pharmacy—for, unfortunately, the doctor's services are often in requisition, generally for wounds. There is not much sickness in the island.

One rises at various hours, from three in the morning to eight, when the inevitable cup of black coffee is presented, and, soon after, breakfast, consisting of a bowl of hot coffee and milk, eggs, and a seaman's biscuit; a light lunch and a dinner of mutton or tunny constitute the meals. Kouskousou, a native stew of grain, vegetables, and of course mutton, is a favourite and very good dish. The servants are a sailor, a Moor, and a cook. The Moor is footman and the sailor housemaid. The butter is churned by Arab women in the villages on the mainland by the tedious process of tossing it to and fro in a skin. Meals are turned into a species of torture by the number of flies, despite Padre Paolo, who exorcises them by waving a birch broom over and into everybody's plate.

The seamen live in the High Street, a long row of buildings accommodating them in batches of eight, sleeping in hammocks. Each batch has

a boy to fag for it. They are paid standing wages of one franc a day, with a bonus on each fish caught, and a share of each catch, which they sell for their own benefit. One of their most valued perquisites is the roe; but half of this they are bound to sell back to the fishery at a fixed price. They have thus a direct interest in the success of each haul. The mechanics who do not fish have, of course, fixed wages. Law and order is represented by an old Arab named Reis Ali, who persists in augmenting the usual attire of a son of Mahomet by a pair of blue breeches.

The most exciting time for every one is when a haul is made.

Nets are laid out in the beginning of spring in the bay. They form a series of chambers, with a long wall of net which intercepts the course of the fish and leads them into one of the outer chambers. The inmost chamber is made of very strong net, with a flooring of net. If the fish do not enter this of their own accord, the skull of an ox or a horse is let down. This attracts the fish, and when sufficient have entered, another net is let down, and they are secured.

The haul is called a *matanza*. Work begins about three in the morning, by the boats being towed out to the nets. There are two large boats, the size and build of a Thames lighter, each towed by four smaller ones with fourteen oars. The two large boats form the ends and the others the sides of an oblong corresponding with the size of the inmost chamber where the fish now are. As soon as the boats are moored the men begin to haul up the nets, when the fun begins. As the fish feel the net moving beneath them they rise to the surface, splashing the water with their tails and drenching the spectator who has not had the forethought to bring a waterproof with him. The *capitano* takes his position in a small boat in the centre of the nets, whence he directs operations, and has a really exciting time. From eight hundred to eleven hundred fish are taken at a time, averaging two and a-half to three hundredweight each, so it will easily be imagined that while the net is being raised they make things very lively. As soon as the net, which requires much noise on the part of the men to raise it, is high enough to bring the fish within reach of the weapons, slaughter, or rather capture, begins. If one is watching the fish rushing about in frantic efforts to escape, it is difficult to see the first attempt at capture; but the fact that it has started is brought to notice by the water being turned to blood colour. A certain number, the *élite* of the men, are armed with long harpoons or hooks. These seize the fish behind the head and draw them to other men armed with short but strong gaff-hooks. If the men with the long hooks are not very expert to seize the fish in exactly the right spot, they often get pulled into the water themselves, and lose their fish and weapon. About six of the men with the shorter hooks seize the fish and haul it up, when, catching hold of two of its fins, they shoot it over the gunwale into the hold, carefully avoiding a blow from its tail. The largest fish are from nine to ten feet long and six in girth. A good-sized one, but by no means the largest, weighed four hundred kilos (over 7 cwt.). As before stated, a successful *matanza* means about one thousand fish, and in favourable years two a week are made during a season of about two months—April and May. When all the fish are caught the nets are let down again, and the weary task of towing the loaded boats home commences, under a sun that is just beginning to gain power. The nets are about three miles from the island. On the way home some of the men are deputed to remove the roe and clean the fish.

When the boats get back, about nine o'clock, the fish are thrown overboard and dragged up a paved incline under two arches, which extend into the water. They then have their head and fins removed by three strokes of an axe, are lifted by eight men on to the back of a ninth, who staggers under the load to a beam, where a rope is fixed round the fish's tail, and it is left hanging. It is a great point of honour with the men that two shall not be employed to carry one fish. By one o'clock all the fish are, or ought to be, hung up, and the men take a rest until evening. The fires are lighted and coppers heated, and at six work begins again, to go on without intermission until ten or eleven the next morning. The first process is cutting up the fish. For this there are three tables about ten feet long, having in front of each a large and somewhat shallow tank with a constant supply of water. It is the duty of the carver to keep this tank full of cut-up fish. A tunny is thrown on the bench, and the chief carver divides it, passing half to each side of him, where it is again divided and subdivided until there remain only little pieces of about six cubic inches. There are five men to each table, and less than two minutes suffice for each fish. The pieces are transferred to other tanks for a second washing, and thence to the coppers opposite. They are not put directly into the coppers, but into strainers which fit the coppers, and are carried there by means of a tramway crane. The process, which goes on all night, is weird and picturesque in the dark—the gloomy arches lit by fitful oil lamps, steam from the coppers, the crane bearing a steaming strainer overhead, the smoke from the chimneys, and the noise of the men and music of the choppers. The cooks have ten-foot ladles for stirring the fish, and wear untanned sheepskin aprons and either jack-boots or none. They never adopt any middle course. When pronounced to be cooked, the fish is carried off, strainer and all, suspended on poles on four men's shoulders, and left to cool in an airy warehouse. When the cooking is done, about ten on the following morning, the men

have the rest of the day to themselves, and on the ensuing morning packing begins. The fish is either salted or put up in oil specially brought from Susa. This olive oil is an expensive item for the fishery. The barrels are packed full of fish, and oil poured in and left to soak, more and more being added as wanted. The head cooper examines each cask before it is stored away, about five thousand barrels being filled yearly. Fish is also put up in tins in the same way, but they are steamed before being closed up. The rest of the fish is salted. This, though it does not require so much care at first, is a longer process. The fish is carved in the usual way, but at different tables, and passed to a man standing on the other side of the table, who dips it in salt. It is then put in a barrel. The barrels are stood in the open, and brine poured in; they are then covered over with salt, which is continually renewed until they hold no more.

The fish in oil is for the Italian market, while that in salt is for the Maltese. At Malta it is sold to vessels going east, being much used where there are lascars on board.

The Campo Santo is wisely placed at the extremity of the island. Here the heads of the fish are hung on beams, and the fins, tails, &c. are left to rot, in which process they yield an oil readily saleable for medicinal purposes.

Everything wanted for the fishery is as far as possible home-made. Tin plates are obtained from England, and all the tinsmiths' work done on the spot. Boxes and barrels are made in the same way. There are blacksmiths who do all the iron-work, including the old-fashioned wooden-stocked anchor. Shipwrights build and mend all the boats, except, of course, the steamer and larger brigs. The nets are perhaps the most important work done, as miles of netting are required. Esparto grass is served out to the wives of the men—they are mostly Sicilian fishermen, who only come over for the season—who make it up into strands during the winter. Before the fishing commences it is made up into ropes, cables, and nets on the island, and each year after the season it is sold for paper pulp. The only net of hemp is the centre net, in which capture takes place. This has to be very strong, the meshes being about an inch in size, while those of the guiding nets are nearer a foot. During a *matanza* every one except the head mechanics has to turn to and fish, whatever his natural trade. Sometimes the fishery meets with ill luck. In 1874 no fish at all were taken, the whole of the nets being washed away. If the weather is rough and there is much sea, the fish may jump over the nets and get away, or if a shark gets caught with them they may break the nets in a stampede. Once the nets were cut to pieces by a steamer out of her course. As before stated, the whole island belongs to the fishery; but it is a very short distance from the mainland, with which it is connected by a foot-bridge in a ruinous state of repair, and by a ford. Any one who has travelled about the country always prefers the safety of a ford to the danger of a bridge the parapet of which is repaired with stones from its buttress. There is no fresh water on the island, and to secure this is the real object of the crazy bridge, pipes being laid along it.

As soon as the fishing is over the fish is all sent off to its destination, and the island left to the custody of some Arab care-takers until the following season.

Not far distant there are a series of caves which are worthy of investigation by some one of better knowledge than that possessed by the islanders. They are elaborately cut in the cliffs, with a shaft to the open air; but there is not even a tradition as to their origin or purpose.

THE ARBUTUS.

HERE Love, with straying feet, shall go
Where Spring's paths meet together;
One way the Winter went, I know;
And it was blust'rous weather.

The snow was falling, wide and white;
In calm it melted slowly;
Again I looked—for well I might—
I saw a blossom holy:

A cream-cheeked thing, on slender stalk,
So timid and so vagrant;
I might to tropic gardens walk
And find no bud so fragrant.

We gathered lilies in the south,
You and I together;
You pressed them to your chin and mouth,
And laughed; 'twas summer weather.

You loosed a lock to fix a rose
That crowned a faery valley;
Caressing it (I saw the pose)
With lightsome wit and sally.

Among the deep blooms of the Fall
I watched your soft hand reaching
Unto (I saw no cardinal)
An answering heaven, beseeching.

But, dear! this trailing, pink-lipped flower,
First of Spring's gentle creatures,
I tender in life's hopeful hour:
The picture of your features.

Green, for your gown; pink, for your blush;
White wreath, for beauty gleaming;
This perfect perfume, for the hush
Of Love, when it is dreaming.

JOHN STUART THOMSON.

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